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MATHEMATICAL RESULTS OF THE PARAMETERS AFFECTING THE UNIFORM SPREADING PRODUCTIVITY OF COMBINED PLOUGH FERTILIZERS USING THE GRAPHO-ANALYTICAL METHOD

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Abstract: The correct application of mineral fertilizer norms and the study of effective energy saving methods, the use of fertilizers in soil and climate conditions for the cultivation of agricultural plants are the urgent tasks of modern agriculture.The main problem in the world is the uneven sowing and disturbance of the ecological situation during the application of fertilizers.So, in many developed countries, the mechanization of this field has been given a lot of attention. Many fertilizer spreading machines and equipment have been produced in this direction. However, in this field, accurate spreading of fertilizers and equal distribution in the soil remains a problem. Uneven fertilization significantly affects the characteristics of the crop and causes environmental pollution.The inhomogeneity of the field in terms of nutrients resulting from fertilization is often the main cause of uneven cropping. It causes yield loss in cereal crops, which can reach 25-60% in some years. Our research has determined that, depending on the design features of the spreaders and the quality of the fertilizers applied, the uneven distribution of the applied fertilizers can vary between 40-60% of the norm, which ultimately leads to nutrient deficiencies. It was observed that the productivity of cereal crops decreased by 11-15 centner/ha with the increase of uneven distribution of fertilizers in the field to 70-80%.In order to partially eliminate the scientific and technical deficiencies in grain growing, a combined plough was developed in our laboratory. Factors affecting productivity were analyzed by the grapho-analytical method of the combined plough, graphs were obtained by theoretical methods.

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Fertilizer rate, optimal selection of the speed of the aggregate creates conditions for obtaining the maximum productivity of mineral fertilizers in the field.Grapho-analytical methods are convenient for selecting the closest targets.

Key words: *Mineral fertilizer, combined plough, productivity, equal amount*.

INTRODUCTION

In order to prevent excessive soil compaction and reduce fuel consumption, it is considered effective to perform several operations in one trip of the tractor with a combined unit [1;2;3;4].At the same time, the combination of plowing operations with equal amounts of fertilizers gives more economic results.

At the "Agromechanics" Scientific Research Institute, a new combined plough was developed in the " Mechanization of crop production " laboratory.

This combined plough cultivates the soil at the same time as well as precise spreading of mineral fertilizers.It was effectively used to give mineral fertilizers to the subsoil.Fertilizer prevents environmental pollution by preventing energy losses at the same time.Here, the fertilizer is not dispersed into the air.Simply ATP-2 fertilizer is applied to the soil through the pipes of the spreader. A smooth spreader is attached to the outlet of the pipes to ensure uniform spreading of fertilizers.The overturned soil rising from the slope of the plough is poured onto the scattered ground.

Figure 1. Combined plough, [5].

The use of the combined plough completely reduces the operation of spreading fertilizer with fertilizer spreaders before the plowing operation, the costs and labor spent on it, at the same time, high efficiency of the use of fertilizers is ensured, i.e., putting the fertilizer under the soil prevents its loss, ensures its uniform spreading, etc. In addition, time is significantly saved and operations can be performed in a short time.

MATERIAL AND METHODS

Theoretical and experimental methods were used in the performance of the work [7]. Experiment planning plays a key role in the efficiency and acceleration of research work [8;9].

The planning of the experiment is to conduct an experiment on the factors that have a serious effect by reducing the number of factors without taking into account the low values of the factors that affect the function by determining the multifactor dependencies with the grapho-analytical method.For this purpose, the regression equation of the multi-factor function is drawn up.

The general expression of the regression all equation 1-2 present:

$$f(y) = a_0 + a_1x_1 + a_2x_2 + \cdots + a_nx_n + a_1a_2x_1x_2 + a_2a_3x_2x_3 + \cdots + \cdots \quad (1)$$

$$a_{n-1}a_nx_{n-1}x_n + a_1x_2^2 + \cdots + a_nx_n^2 + \cdots \quad (2)$$

is written as here:

$a_1 ... a_n$ are regression coefficients;

$x_1 ... x_2 ... x_n$ are studied parameters.

One of the main issues is the determination of the regression coefficient.

Determining these coefficients by different methods (least squares, etc.) creates difficulties by requiring a lot of time. The importance of determining the coefficients is that if those coefficients have a relatively small and negative value, then the parameters representing those coefficients are shortened and the number of experiments is reduced.Taking these into account, we have developed a methodology for determining those coefficients using a simple method and suggested its application. The essence of that method is that the minimum and maximum values of the sought parameter are determined, the value of the function on the ordinate axis, and the value of the argument on the abscissa axis are indicated by the scale, and the tangent (tgα) of that dependence is determined.

The coefficients indicated in the regression equation are replaced by a_1, a_2,...,an $tg\alpha_2$, ..., $tg\alpha_n$.

$$f(y) = tga_0 + tga_1x_1 + tga_2x_2 + \cdots + tga_nx_n + tga_1tga_2x_1x_2 +$$

$$+tga_2tga_3x_2x_3 + tga_{n-1}tga_nx_{n-1}x_1 + (tga_1x_2)^2 + \cdots + (tga_nx_n)^2 \quad (3)$$

should be written in the form.

This dependence can be shown on the coordinate axis as follows.

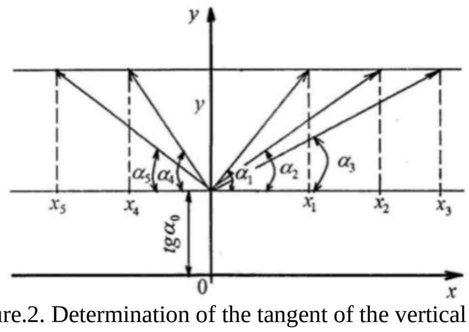


Figure.2. Determination of the tangent of the vertical axis on the abscissa axis of the ordinate axis

As you can see from this graph

$a_0 = tga_0;\ tga_1 = \frac{y}{x_1};\ tga_2 = \frac{y}{x_2};\ tga_3 = \frac{y}{x_3};$

$tga_4 = \frac{y}{x_4};\ tga_5 = \frac{y}{x_5}$ … … … … … … … … … … … … … … …. … … … … … (4)

If we solve and sum these expressions with respect to y:

$$\Sigma y = tga_0 + tga_1x_1 + tga_2x_2 - tga_3x_3 - tga_4x_4 - tga_5x_5 + tga_1tga_2x_1x_2 + \\ +tga_2tga_3x_2x_3 + tga_3tga_4x_3x_4 + tga_4tga_5x_4x_5 + tg^2a_1x_1^2 + tg^2a_2x_2^2 + \\ tg^2a_3x_3^2 + tg^2a_4x_4^2 + tg^2a_5x_4^2 \qquad (5)$$

we receive their statements.

Here, any coefficient that is small or negative is excluded from the regression equation.

So, suppose that tg α_3 is small, tg α_4 and tg α_5 are negative, then the regression equation

$$\Sigma y = tga_0 + tga_1x_1 + tga_2x_2 + tga_1tga_2x_1x_2 + tg^2a_1x_1^2 + tg^2a_2x_2^2\ ; \qquad (6)$$

takes the form and thus it is appropriate to carry out the transformation of the function based on the arguments x_1 and x_2.

RESULTS AND DISCUSSION

In laboratory conditions, the working body of the combined plough, the scattering productivity of the smooth spreader was determined.We can write a mathematical formula based on the diameter d of the support wheel of the combined plough, the spreading working width of the machine B, the fertilizer rate Q and the working speed.

$$W_s = \frac{4 \cdot Q \cdot v}{\pi \cdot d \cdot B}\ ; \quad g/m^2 \qquad (7)$$

here:

W_s – fertilizer spreading efficiency, g/m^2
Q – the amount of fertilizer poured from the fertilizer tube in 1 cycle of the support wheel, g
d – the diameter of the support wheel, d=0.35 m
B- is the overall working width of the smooth spreader, B=1.4 m
v – unit speed, v = 1.67 m/sec
$\pi = 3.14$

Dependence of dispersion productivity on aggregate speed (v).

$W_s = f(v)$

$W_s = \frac{4 \cdot 7{,}84 \cdot V}{3{,}14 \cdot 0{,}35 \cdot 1{,}4} = 20.38\ v$

If we write the value $v = 1.67$ m/sec instead

$W_s = 34.04$ g/m^2 ; tg $\alpha_1 = \frac{w_s}{v} = \frac{34.04}{1.67} = 20.38^o$

2) Dependence of scattering productivity on the fertilizer rate (Q)

$W_s = f(Q)$; $W_s = \frac{4 \cdot Q \cdot 1.67}{3.14 \cdot 0.35 \cdot 1.4} = 4.34 \cdot Q$

If we take Q = 7.84 g

$W_s = 34.04$ g/m^2

tg $\alpha_2 = \frac{w_s}{Q} = \frac{34.04}{7.84} = 4.34^o$

3) Dependence of spreading productivity on the working width (B) of the smooth spreader

$W_s = f(B)$

$W_s = \frac{4 \cdot 7.84 \cdot 1.67}{3.14 \cdot 0.35 \cdot B} = 47.65 \, \frac{1}{B}$

If B = 1.4 m

$W_s = 47.65 \, \frac{1}{1.4} = 34.04$ g/m^2

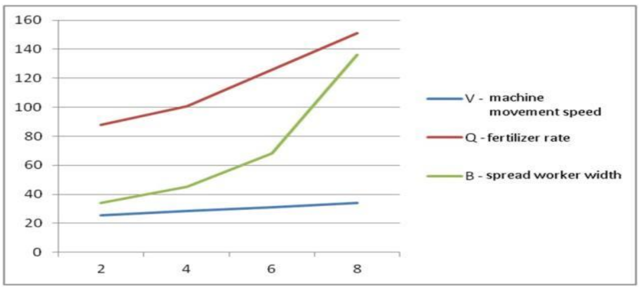
tg $\alpha_3 = \frac{w_s}{B} = \frac{34.04}{1.4} = 24.31^o$

according to the obtained results, the regression equation is as follows

$\sum W_s = 20.38 \cdot v + 4.34 \cdot Q + 47.65 \cdot \frac{1}{B} + ... + ...;$

$\sum W_s = 20.38 \cdot v + 4.34 \cdot Q + 47.65 \cdot \frac{1}{B} + 20.38 \cdot 4.34 \cdot v \cdot Q + 20.38 \cdot v^2 + 4.34 \cdot Q$

W_s,g/m^2



8 partitions

8 partition channels are written on the x-axis, and fertilizer sowing productivity is written on the y-axis

Figure. 3 Factors affecting sowing performance

From the graph in Fig.3, it is clear that W_s - the 1st factor that most affects the sowing productivity Q - fertilizer rate, 2nd factor B- spread worker width,3- the less influential factor V is the speed of movement of the machine [5;6].

Table. 1 Price table of factors affecting productivity

$V_{işçi}$, m/s	1.25	1.39	1.53	1.67
W_s g/m^2	25.48	28.33	31.18	34.04
$B_{işçi}$, m	0.35	0.70	1.05	1.40
W_s g/m^2	34.05	45.39	68.07	136
Q, g	20.27	23.18	29	34.8
W_s g/m^2	87.97	100.6	125.86	151.03

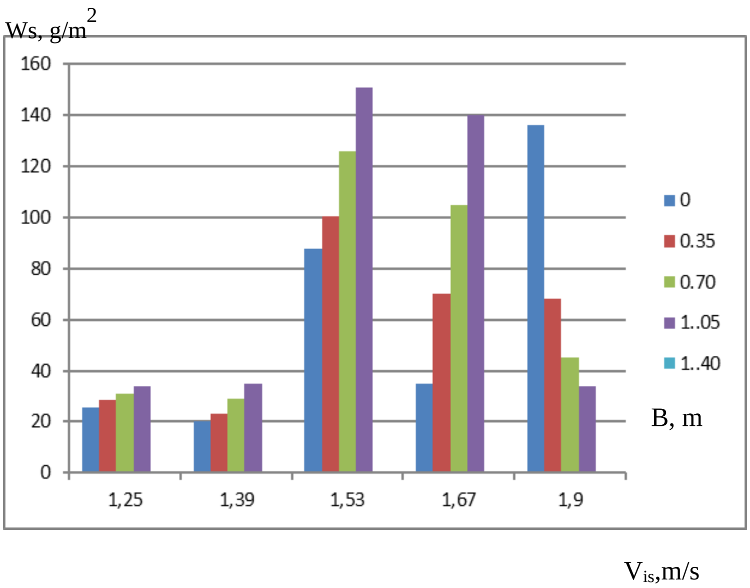


Figure. 4. Fertilizer sowing productivity depending on the working width and speed of the machine

Table 2. Economic comparison

s/s	The name of indicators	Unit of measurement	Mechanization options			
			SP -12 plough	Amazone ZA M -1500	Single time operations Total	Experimental Combined plough
1.	Productivity	ha/h	0.72	5.12	0.72	0.72
2.	Duration of technological operation	h	450	450	450	450

Cont.Table 2.

3.	Capital investment	dollars	8.17	20.05	28.22	14.88
4.	Depreciation expense	dollars	398.22	3.4	401.62	399.18
5.	Current repair and maintenance costs	dollars/ha	16.40	6.48	22.88	17.89
6.	Fuel and lubricant cost	dollars/ha	12.23	1.72	13.95	12.23
7.	Operating costs	dollars	1346.9	931.91	2278.80	1348.74
8.	Costs incurred	dollars	1348.94	936.92	2285.86	1352.45
9	Economic efficiency	dollars	-	-	-	933.40
10.	Economic efficiency in	ha/dollars	-	-	-	123.53
	grain growing	kg/ha	-	-	-	600
11.	Economic efficiency	dollars	-	-	-	40023.53
	during the growing season in grain growing	t	-	-	-	194.4
12.	Overall economic benefit	dollars	-	-	-	40956.93

Table 2 shows a comparative analysis of technological operations. Thus, the smooth and even distribution of mineral fertilizers in the field with the use of combined plough increases the productivity in grain growing from a minimum of 26 centner/ha to 32 centner/ha.

If we calculate that a kilogram of wheat costs about 21 cents, 600 kg per hectare allows us to get an economic economic income of 123.5 dollars / ha, and during the season - 3200 ha of land with an economic benefit of 40 003 dollars.

CONCLUSION

1. Plowing and fertilizing work on the slopes was performed in one go by using the combined plough. Fertilizing evenly under the soil prevents environmental pollution and increases the efficiency of fertilizer use.
2. As a result of economic testing of the combined plough, the working speed was 4 ... 6 km/h, the working width was 1.51 m, the cultivation depth was 20 ... 25 cm, the fertilizer application rate was 65 ... 328 kg/ha.
3. Uniform distribution of urea fertilizer under the soil was 92.0%, double superphosphate - 94.0%, potassium chloride - 93.0%.
4. Field and farm experiments have shown that with the reduction of uneven dispersion of mineral fertilizers with experimentally combined plough provides 20% of minimum green mass productivity and grain growth of 600 kg/ha.
5. As a result of the application of the combined plough, labor costs are reduced by 14.65% and operating costs by 18.3% compared to the usual method.
6. The annual economic benefit of one device is US $933.4 due to the difference in costs incurred.
7. Fertilizer rate and unit speed are the main factors affecting the productivity of fertilizer spreading in the technological operation carried out by the combined plough.

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MATEMATIČKI REZULTATI ISTRAŽIVANJA PARAMETARA KOJI UTIČU NA UJEDNAČENU PRODUKTIVNOST RASIPANJA MINERALNIH ĐUBRIVA SA KOMBINOVANIM PLUGOM, PRIMENOM GRAFO-ANALITIČKE METODE

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Apstrakt: Proučavanje efikasnih metoda uštede energije kod primene određenih normi primene mineralnih đubriva, korišćenje đubriva u zemljišnim i klimatskim uslovima za uzgoj poljoprivrednih kultura je urgentan zadatak savremene poljoprivrede.

Glavni problem u Svetu je neujednačenost. setve i narušavanja ekološke situacije pri primeni mineralnih đubriva.

Dakle, u mnogim razvijenim zemljama se mehanizaciji ove oblasti poklanja velika pažnja. U tom pravcu proizvedeno je mnogo različitih mašina i oprema za rasipanje mineralnih đubriva.

Međutim, praktično u polju, tačno rasipanje đubriva i ravnomerna raspodela u zemljištu ostaje problem.
Neravnomerno đubrenje značajno utiče na karakteristike useva i izaziva zagađenje životne sredine. Nehomogenost zemljišta u pogledu hranljivih materija koja nastaje đubrenjem je često glavni uzrok neujednačenih razvoja useva i prouzrokuje gubitak prinosa kod žitarica, koji može dostići 25-60%

Istraživanjem je utvrđeno da, u zavisnosti od konstrukcijskih karakteristika rasipača i kvaliteta primenjenog mineralnog đubriva, neravnomerna raspodela primenjenog đubriva može da varira između 40-60% od norme, što na kraju dovodi do nedostataka hranljivih materija. Uočeno je da je produktivnost žitarica opala za 11-15 centi/ha uz povećanje neravnomerne raspodele đubriva u polju za 70-80%.

Da bi se delimično otklonili naučno-tehnički nedostaci u gajenju žitarica, u tu svrhu je razvijen kombinovani plug u našoj laboratoriji i Institutu Ganja, Azerbejdžan.

Faktori koji utiču na produktivnost analizirani su grafo-analitičkom metodom za kombinovani plug, a grafikoni su dobijeni primenom teorijskih metoda.

Ujednačenost rasipanja đubriva, optimalani izbor brzine agregata stvara uslove za dobijanje najveće produktivnosti korišćenja mineralnih đubriva na polju.

Primenjene grafo-analitičke metode su pogodne za prikazivanje najbližih ciljeva istraživanja.

Ključne reči: *Mineralno đubrivo, kombinovani plug, produktivnost, jednaka količina*

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